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Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives

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CANADIAN POWER IMPORTS

Update on Electricity Imports in the Northeast

GAO/RCED-89-51

GAO

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

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March 3, 1989

The Honorable John D. Dingell
Chairman, Subcommittee on Oversight
and Investigations
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

In April 1986, we provided you our report entitled Canadian Power Imports: A Growing Source of U.S. Supply (GAO/RCED-86-119). At your request, we met in January 1988 and discussed matters related to the electric utility industry and, in particular, indications that utilities were reluctant to undertake the construction of major power plants. One of these indications concerned efforts by northeastern U.S. utilities to negotiate additional large purchases of power from Canadian utilities. We agreed to provide you updated information concerning (1) the status of long-term firm-power[1] contracts between Canadian utilities and utilities in the northeastern United States and (2) the reliability of one of the Canadian utility power systems that serves northeastern United States utilities—Hydro-Quebec.

At that time, we also agreed that, following our effort to update Canadian electricity imports, we would begin a review of the trend toward utilities' decisions to purchase future electricity supplies rather than undertake major power plant construction programs. We are now in the preliminary stages of that work. This letter and accompanying appendixes provide the results of our update of Canadian electricity imports.

Results in Brief

Overall, we found that between January 1986 and December 1988, northeastern U.S. utilities had signed two contracts and one preliminary agreement for longer term firm power. All three were with Hydro-Quebec, a Canadian provincial utility. These new agreements indicate that northeastern utilities are, in our opinion, continuing to view Canadian electricity purchases as one economic alternative for obtaining future power resources.

[1] A firm-power contract requires that power be made available on demand to the buyer during the contract period. Thus, utilities can rely on firm-power purchases almost as they would on their own internally generated capacity.

With regard to one of the two signed contracts, in a January 9, 1989, Maine Public Utilities Commission action, the Commission denied the utility's request to make the purchase of Hydro-Quebec power, stating its view that other alternatives, such as energy conservation and development of small power production, had the potential of providing more economical sources of power. The second contract is expected to be reviewed by the Vermont public utility commission in early 1989.

We also found that the basis for technical reliability concerns that we discussed in our earlier report is still evident in the Hydro-Quebec electric system. To address these problems, U.S. utilities have established operational limits on the amount of power that should be imported from Hydro-Quebec at any one time, and Hydro-Quebec has developed plans to make major improvements in its transmission system.

The key results of our review are highlighted in this letter. Appendixes I through III contain more detailed data on U.S./Canadian electricity trade (1965-87), information about U.S./Canadian long-term firm-power contracts, and a discussion of the reliability issue associated with electric power imported from Hydro-Quebec. A description of the objectives, scope, and methodology of our review is contained in appendix IV.

Background

For a number of years U.S. utilities have purchased electricity from Canadian utilities. These purchases (for the most part referred to as "displacement purchases") have saved U.S. consumers hundreds of millions of dollars. As discussed in our 1986 report, such purchases occurred primarily because Canadian provincial utilities had electricity that was surplus to their needs and offered it to U.S. utilities at a price which was less than what it cost U.S. utilities to produce electricity in their own power plants.

Additionally, we reported that since 1981, U.S. utilities had purchased increasing quantities of Canadian electricity to meet their electricity generation capacity needs and that such purchases had the effect of deferring the construction of domestic power plants that otherwise would be needed. More specifically, our report identified six New England year-round firm-power or firm-energy contracts[1] that had been

[1]A firm-energy contract obligates the seller to supply and the buyer to accept a fixed amount of energy over a given period of time. The amount of power delivered may vary from hour to hour and is not necessarily available to the buyer on demand, but the total energy contracted for is to be delivered over the contract period.

signed by New England and Canadian provincial utilities, as shown in table 1.

Table 1: Pre-1986 New England Firm-Power and Firm-Energy Purchase Agreements

Amount (MW)[a]	Parties	Number	Type	Length (years)	Start
1,500[b]	Hydro-Quebec NEPOOL utilities	1	Firm-energy	10	1990
230	New Brunswick Electric Power Commission Massachusetts/ Maine Utilities	4	Firm-power	5	1983[c]
150	Hydro-Quebec Vermont Department of Public Service	1	Firm-power	10	1985

[a]MW=megawatts.

[b]This agreement is for 70 million megawatt hours (MWH). The New England Power Pool (NEPOOL), using a computer model, has valued this energy to be equivalent to a 1,500-MW purchase.

[c]The purchasing utilities can exercise options to extend the contracts to 1991.

Deliveries totaling 380 megawatts (MW) under the five firm-power contracts have started. Deliveries under NEPOOL's firm-energy contract are scheduled to begin in 1990, after an existing NEPOOL/Hydro-Quebec interconnection's capacity is increased.[3]

With regard to the future role of Canadian electricity imports, we reported in 1986 that, based on then-existing contractual arrangements, the amount of Canadian electricity imported by U.S. utilities was expected to grow at least through 1995 and beyond the year 2000 if ongoing contract negotiations were successful. We also noted that Canadian electricity imports would likely be used more extensively in the future as a substitute for building power plants in the United States.

Our 1986 report also discussed a number of issues associated with Canadian electricity imports. One concern, expressed by New England utility representatives, centered on the technical reliability of power from the Canadian province of Quebec. This concern grew as U.S. utilities and regulators looked at the issue of technical reliability and the planned increase in capacity in the transmission interconnection that was required for NEPOOL's firm-energy contract noted above. We reported that this issue was under study by affected parties and that NEPOOL and

[3]NEPOOL's existing interconnection, known as Phase I, has a 690-megawatt capacity. Under Phase II, this interconnection is scheduled to be increased to 2,000 megawatts to accommodate NEPOOL's firm-energy purchase.

Hydro-Quebec were taking steps to improve the reliability of interconnections.

Recent Agreements Reflect Longer Term Contracts for Firm Power

Our review showed that since 1985, six additional firm-power contracts and a preliminary agreement for purchasing firm power had been reached between Canadian provincial utilities and U.S. utilities in New England and New York (northeastern utilities). (Table 2 identifies these seven arrangements.) In addition, Canadian utilities had made additional proposals for long-term firm-power exports.

Table 2: New England/New York Firm-Power Contracts Signed Since 1985

Amount (MW)	Parties	Number	Length (years)	Start
1,000	Hydro-Quebec New York Power Authority[a]	1	21	1995
900	Hydro-Quebec Central Maine Power	1	29	1992
450	Hydro-Quebec Vermont Joint Owners	1	30	1990
120	New Brunswick Electric Power Commission Maine utilities	2	1	1987
73	Ontario Hydro Vermont Department of Public Service	1	5	1987
50	Hydro-Quebec Vermont utilities	1	3	1987

[a]This is a preliminary agreement. The parties expect to sign a contract early in 1989.

Three of the arrangements shown in table 2 reflect relatively large purchases of Canadian power over much longer periods (21 to 30 years) than those contracts discussed in our 1986 report (5 to 10 years). More specifically, both Central Maine Power and a group of Vermont utilities had signed contracts and the New York Power Authority had reached agreement with Hydro-Quebec for longer term firm-power purchases. The U.S. utilities view these arrangements as a means of ensuring a long-term electricity supply at relatively predictable prices.

While the U.S. utilities and Hydro-Quebec had reached the above long-term agreements, the Central Maine Power and Vermont utilities' contracts were contingent on the approval of the utilities' respective state public utility commissions.

On January 9, 1989, the Maine Public Utilities Commission denied Central Maine Power's application for approval of its contract with Hydro-Quebec. The Commission found that (1) cogeneration and small power production and (2) conservation and load management alternatives had additional potential beyond that considered by Central Maine Power for providing less costly power than that offered by Hydro-Quebec. The Vermont joint owners plan to submit their contract with Hydro-Quebec to Vermont's public utility commission in early 1989. The New York Power Authority arrangement will not require regulatory approval since the authority is a state agency.

In addition to the contracts/agreements discussed above, Canadian provincial utilities have made proposals for additional long-term firm-power exports to begin in the 1990s but formal agreements with U.S. utilities have not been reached. For example, Nova Scotia has proposed that either a 900-MW or 1,200-MW generation plant be built and dedicated to U.S. exports for 30 years. The proposal calls for a 250-mile underwater transmission cable to be built between Nova Scotia and Massachusetts. Another proposal calls for the delivery of 600 MW, beginning in 1994, from the New Brunswick Electric Power Commission, and up to 900 MW if a proposed new interconnection between New Brunswick and Maine is completed.

GAO's Observation

Our work showed that since 1985, there has been an increase in the number of firm-power agreements between northeastern U.S. utilities and Canadian provincial utilities. Our work also showed that some of these agreements represented relatively large year-round purchases of firm power for longer periods of time.

Projections for imported power show that Canadian imports will continue to contribute to northeastern U.S. utility capacity. According to the most recent NEPOOL forecast, Canadian imports, which currently represent 3 percent of New England's capacity, will peak at 8.5 percent in 1991. For New York, according to the most recent New York Power Pool forecast, firm-power imports will contribute a maximum of 4.9 percent to New York utilities' capacity; that maximum will be reached in 1996. The projected share that Canadian purchases contribute to New England utilities' capacity is similar to that described in our previous report. New York utilities did not have year-round firm-power contracts with Canadian utilities at the time of our previous work.

Issue of Technical Reliability Continues, but Actions Being Taken

In our April 1986 report, we discussed New England utility representatives' concern about the technical reliability of the Hydro-Quebec electric system and, more specifically, the vulnerability of that system to major power outages. The concern centered around the likelihood that should such Hydro-Quebec system power outages occur, they could adversely affect neighboring interconnected systems such as NEPOOL and, in turn, other interconnected U.S. systems. Hydro-Quebec's vulnerability to system outages stems from the long distances between the utility's generation facilities and its customers.

Hydro-Quebec has experienced 10 system-wide outages since 1969. However, the frequency of such occurrences has decreased in recent years. More specifically, Hydro-Quebec experienced eight system-wide power outages during the 10-year period from 1969 through 1978, but the utility experienced only two such outages during the next 10-year period, 1979 through October 1988—the most recent outage occurring in April 1988. According to Hydro-Quebec officials, system-wide outages decreased after 1978 because new transmission facilities were installed to connect the utility's James Bay hydroelectric generation facilities and other improvements were made to its transmission system.

Since our prior work, actions have been taken and further action is being considered to address reliability concerns. First, U.S. utilities have established operational limits on the amount of electricity to be imported from Hydro-Quebec. Second, Hydro-Quebec has developed a plan, which is being reviewed by the Northeast Power Coordinating Council (NPCC),[1] to modify and upgrade its electric transmission system at an estimated cost of between $600 million and $800 million (Canadian).

Operational Limitations Placed on U.S. Transmission Interconnections With Hydro-Quebec

U.S. utilities interconnected with Hydro-Quebec's main power transmission grid (main grid) established, in 1986, an operational limit on the amount of power that can be imported from Quebec. While the specific limit varies on the basis of certain operating conditions and power system configurations, the current limit is generally considered to be 2,200 MW. The limit is based on the U.S. utilities' assessment of their ability to

[1]NPCC, which represents utilities in the northeastern United States and the Canadian provinces of New Brunswick, Nova Scotia, Ontario and Quebec, is one of nine regional councils that comprise the North American Electric Reliability Council (NERC). NERC was formed in 1968 to promote power supply adequacy and electric system reliability. It is composed of nearly all the electric utilities in North America.

compensate for a sudden loss of that amount of power over the four existing interconnections with Hydro-Quebec's main grid.

In June 1988, NPCC completed a series of studies (referred to in our earlier report) that examined the reliability of increasing NEPOOL's interconnection with Hydro-Quebec to 2,000 MW.[1] The studies focused on issues associated with a loss of power over existing interconnections between Quebec and the United States, as well as the loss of power expected to be transmitted over NEPOOL's planned Phase II interconnection. Two major conclusions from these studies were that:

- The Phase II interconnection can be designed and operated so that it will not adversely affect the reliability of the eastern U.S. electric power system.
- Appropriate operating procedures were needed to limit the amount of power transmitted over the upgraded interconnection as well as other interconnections between Hydro-Quebec's main transmission grid and eastern U.S. electric power systems.

The planned Phase II interconnection, which is to be completed in 1990, is being constructed so that the transmission line and associated generating facilities can normally be operated in isolation from Hydro-Quebec's main transmission grid. Thus, when the interconnection is operated in its isolated mode, it should not be affected by any Hydro-Quebec main grid system outage, should that occur. When the Phase II interconnection is not operated in its isolated mode, the total power imported over all interconnections with Hydro-Quebec (including the Phase II interconnection) will be subject to the 2,200-MW operating limit discussed above.

In addition, a separate limit on the amount of power flowing over the Phase II line, depending on operating conditions, will apply when the interconnection is operating in its isolated mode. The specific limit will be based on the ability of U.S. utilities to withstand the loss of power from this single source rather than on Hydro-Quebec's current vulnerability to system-wide outages.

[1]Two other NERC regional councils that are interconnected with New England power systems participated in one study that examined the effect of the Phase II interconnection on their electric systems—the Mid-Atlantic Area Council and the East Central Area Reliability Coordination Agreement. These councils represent neighboring utilities to the west and south of the Northeast Power Coordinating Council.

Hydro-Quebec Actions to Improve System Reliability

Hydro-Quebec is taking steps to enhance the reliability of new interconnections to its overall power system. As indicated above, Hydro-Quebec is designing the Phase II interconnection so that it can normally be isolated from its main grid and, therefore, not be subject to its main grid outages. Additionally, Hydro-Quebec has conducted technical studies on ways to improve the reliability of its overall transmission system and thus lessen the likelihood of outages. On the basis of these studies, Hydro-Quebec developed a plan to make significant transmission system improvements and provided its plan to NPCC. Hydro-Quebec is seeking NPCC's views as to whether its planned improvements would conform to NPCC's transmission reliability criteria. Should NPCC respond favorably to the plans, Hydro-Quebec plans to spend up to $800 million (Canadian) on transmission system improvements beginning in 1989. Hydro-Quebec officials believe that such improvements would then lead to the lifting of the current 2,200-MW operational limit.

Recent Interruptions of Power From Hydro-Quebec

In January and April 1988, U.S. utilities experienced curtailments of power being delivered from Hydro-Quebec under contract. These curtailments differed in that the January curtailment resulted from an operational decision of Hydro-Quebec, in conjunction with NEPOOL representatives, to interrupt power deliveries, while the April curtailment resulted from technical failures within Hydro-Quebec's power system. These situations are summarized below.

On January 6, 7, 14, and 15, 1988, during severe winter weather conditions, Hydro-Quebec and NEPOOL mutually agreed to interrupt deliveries of firm power being provided under a short-term contractual agreement. Curtailments of up to 690 MW of power were made on each of those 4 days. According to NEPOOL and Hydro-Quebec officials, it was mutually recognized that the Hydro-Quebec operating reserves were low, while NEPOOL could continue to serve its firm-power customers without the Hydro-Quebec power. A NEPOOL official stated that, overall, the firm-power contract with Hydro-Quebec played a significant role in enabling NEPOOL to meet its winter supply needs and that the power was interrupted for only 4 days during the 3-month contract period. This official also told us that, pursuant to the contract provisions, Hydro-Quebec paid a total penalty of $955,385 for the interruptions.

The curtailment on April 18, 1988, exemplifies how problems experienced in Hydro-Quebec's transmission system can affect other interconnected systems. According to Hydro-Quebec, icing conditions and technical equipment failure led to the April 18th system-wide outage

that involuntarily curtailed the delivery of 1,803 MW of power being exported to U.S. utilities. Of the total amount of power lost, 1,323 MW represented power being transmitted over the four interconnections that tie New England utilities to Hydro-Quebec's main transmission grid. According to Hydro-Quebec officials, its planned transmission system improvements, discussed above, are designed to reduce the likelihood of these types of system-wide outages and provide a level of reliability that is consistent with the reliability criteria of the Northeast Power Coordinating Council.

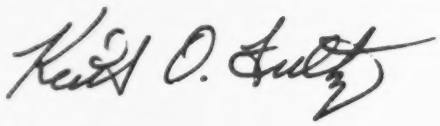
The remaining loss of 480 MW of power on April 18, 1988, represented power being transmitted from Hydro-Quebec's Beauharnois generating facility to New York. Both New York Power Authority and Hydro-Quebec utility representatives had believed that the Beauharnois facility was operating in isolation from Hydro-Quebec's main grid and thus would not be affected by a main grid system outage. However, it was subsequently determined that the auxiliary equipment operating the facility's generating units was incorrectly linked to Hydro-Quebec's main grid. Thus, at the time of the power outage, 8 of the facility's 14 generating units were involuntarily shut down. A Hydro-Quebec official stated that operating procedures were subsequently implemented to completely isolate the Beauharnois facility from Hydro-Quebec's main grid. A New York Power Authority official stated that the Authority is satisfied with the steps Hydro-Quebec has taken to correct the problem.

Our review was conducted between February 1988 and January 1989, in accordance with generally accepted government auditing standards. We discussed matters of fact contained in this report with officials from the Department of Energy and appropriate U.S. and Canadian utilities, a state regulatory agency, and various electric utility industry organizations and associations. However, as requested by your office, we did not obtain official agency comments on a draft of this report.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution until 30 days from the date of this letter. At that time, we will provide copies to the Department of Energy and to other interested parties upon request.

The major contributors to this report are listed in appendix V.

Sincerely yours,



Keith O. Fultz
Director, Energy Issues

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Abbreviations

CMP	Central Maine Power
DOE	Department of Energy
GAO	General Accounting Office
MW	megawatts
MWH	megawatt hours
NEPOOL	New England Power Pool
NERC	North American Electric Reliability Council
NPCC	Northeast Power Coordinating Council

Electricity Imports From Canada to the United States

From 1965 to 1968, the flow of electricity between the United States and Canada was fairly balanced. However, since 1969 the United States has consistently imported more power from Canada than it has exported (see table I.1). By 1987, U.S. utilities imported 14 times as much electricity from Canada as they exported.

Although Canadian imports provided only 1.4 percent of total U.S. electricity consumption in 1986, they constituted about 9 percent and 12 percent of electricity in New England and New York, respectively. (See table I.2.)

Table I.1: Electricity Trade Between the United States and Canada, 1965-87

MWH and dollars in thousands

Year	U.S. importsfrom Canada (MWH)	U.S. exports to Canada (MWH)	Trade surplus (deficit)
1965	3,570	3,575	$1,704
1966	4,310	3,057	(5,540)
1967	4,066	4,142	5,744
1968	3,646	4,129	2,529
1969	4,688	3,333	(9,474)
1970	5,631	3,245	(22,460)
1971	6,985	3,378	(37,826)
1972	10,379	2,381	(62,206)
1973	16,879	2,249	(108,633)
1974	15,399	2,441	(172,191)
1975	11,375	4,174	(100,285)
1976	12,804	3,590	(169,541)
1977	19,957	2,690	(382,176)
1978	21,602	2,092	(418,146)
1979	31,378	1,792	(630,083)
1980	30,180	2,940	(675,997)
1981	35,372	1,497	(949,308)
1982	34,220	2,849	(892,497)
1983	38,830	3,179	(1,008,428)
1984	41,842	2,750	(1,054,137)
1985	43,416	3,091	(1,036,612)
1986	38,934	4,956	(775,106)
1987	47,426	3,471	(905,424)

Note: Amounts reflect all electricity trade between the United States and Canada, including that sold through firm-power and non-firm-power contracts and through power exchanges.

Source: Canadian National Energy Board; surplus and deficit amounts converted to U.S. dollars by GAO

Table I.2: Selected Regional Electricity Imports From Canada, 1986

Figures in 1,000 megawatt hours

	Lower Michigan	Upper Midwest	New England	New York
Electricity requirements	74,930	106,824	99,363	128,502
Electricity imports	688	7,837	9,142	15,462
Net imports as a percentage of electricity use	.9	7.3	9.2	12.0

Note: Includes displacement transactions as well as firm-power and firm-energy transactions.

Source: DOE, Electricity Transaction Across International Borders, 1986 (October 1987).

Long-Term Firm-Power Contracts With Hydro-Quebec

Between January 1986 and December 1988 Hydro-Quebec signed two long-term firm-power contracts with New England utilities and reached a long-term firm-power agreement with the New York Power Authority (the Authority). The performance period for the contracts and agreement ranged from 21 to 30 years, but deliveries of power were to occur in 20-year "blocks" that began at various times throughout the contract period.

Each contract was contingent upon the approval of the U.S. utilities' respective state public utility commission. One of these contracts was disapproved by the respective commission on January 9, 1989. The other contract is expected to be submitted for commission approval in early 1989.

Maine Contract

On July 20, 1988, Central Maine Power (CMP) and Hydro-Quebec signed a 29-year 900-MW firm-power contract valued at $9 billion. The Maine Public Utilities Commission denied approval of this contract on January 9, 1989.

CMP had planned to purchase a minimum of 300 MW. The first 20-year block of power was scheduled to begin in 1992 at 100 MW, a second 100-MW/20-year block purchase was scheduled to begin in 1995, and a third 100-MW/20-year block purchase was scheduled to begin in the year 2000. The utility had considered exercising options to purchase an additional 300 MW. Based on a total 600-MW purchase, CMP had estimated its portion of the 900-MW contract to be valued at $7.9 billion. Hydro-Quebec could have sold to other utilities any portion of the contract not purchased by CMP.

CMP's proposed purchase from Hydro-Quebec was the only new long-term firm-power contract we identified that required the establishment of a new interconnection and construction of a transmission line. The interconnection was planned to have a 1,100-MW capacity. The U.S. portion of the transmission line was estimated to cost $250 million. CMP applied to the Department of Energy (DOE) for a Presidential Permit for the new interconnection.[1] DOE had expected to complete its review of the CMP permit application by the end of 1989. However, because of the

[1] As discussed in our 1986 report, DOE is responsible for issuing Presidential Permits to utilities that propose to construct transmission lines across the U.S. international border. Under Executive Order 10485, construction of such transmission lines is required to be licensed (Presidential Permit). In its review process for permit applications, DOE makes an environmental impact evaluation and a technical reliability assessment.

recent action by the Maine Public Utilities Commission, CMP, according to a DOE official, requested that DOE place CMP's application on "hold".

On January 9, 1989, the Maine Public Utility Commission denied Central Maine Power's petition for approval of its purchase from Hydro-Quebec. As part of the approval process, CMP was required to demonstrate that it had weighed all reasonable supply and demand options over a projected 30-year period, and that its proposed purchase was its "least cost" plan. A recently enacted Maine law requires that new sources of power must be shown to be superior to additional investments in energy conservation and load management and greater reliance on cogeneration and small power production facilities. While CMP had included in its future resource plans new electricity supplies from these sources, the Commission found that CMP had not adequately assessed the extent to which these sources could be relied upon. It also found that these alternatives were available at prices near to or better than the Hydro-Quebec contract price. Consequently, the Commission concluded that the contract was not Central Maine Power's least- cost energy plan and was not superior to additional cogeneration or small power purchases, or conservation and load management alternatives.

Vermont Contract

On December 4, 1987, a group of nine Vermont utilities signed a 500-MW firm-power contract with Hydro-Quebec. Subsequently, the Vermont utilities exercised options to reduce the purchase to 450 MW, which they estimate to be valued at $4.6 billion. The Vermont utilities can reduce the 450-MW purchase to 340 MW by 1996. Power delivered under this contract will, in part, be transmitted over an existing interconnection between Vermont and Hydro-Quebec. The Vermont utilities plan to submit their proposed purchase to the Vermont public utility commission in early 1989.

New York Agreement

On January 6, 1988, the New York Power Authority signed a preliminary firm-power agreement with Hydro-Quebec, covering a 21- year period, for 1,000 MW valued at $11.7 billion. The Authority plans to sign a final contract early in 1989 and resell up to 800 MW of this power to three New York utilities. The power under this agreement can be purchased in two 500-MW/20-year blocks. Delivery of power under the first 20-year block is to begin in 1995; the second 20-year block is to begin in 1996. Since the authority is a state agency, power delivered to the authority is not subject to review by that state's public utility commission.

Reliability of Hydro-Quebec Power

As discussed in our April 1986 report, Hydro-Quebec is vulnerable to system-wide power outages and such outages can adversely affect interconnected power systems. Even though this situation is still evident, the frequency of system-wide outages has decreased. Hydro-Quebec has developed plans to upgrade the Hydro-Quebec transmission system, and Hydro-Quebec and U.S. utilities are increasing interconnection capacity between their respective power systems.

System-Wide Outages Linked to Transmission System

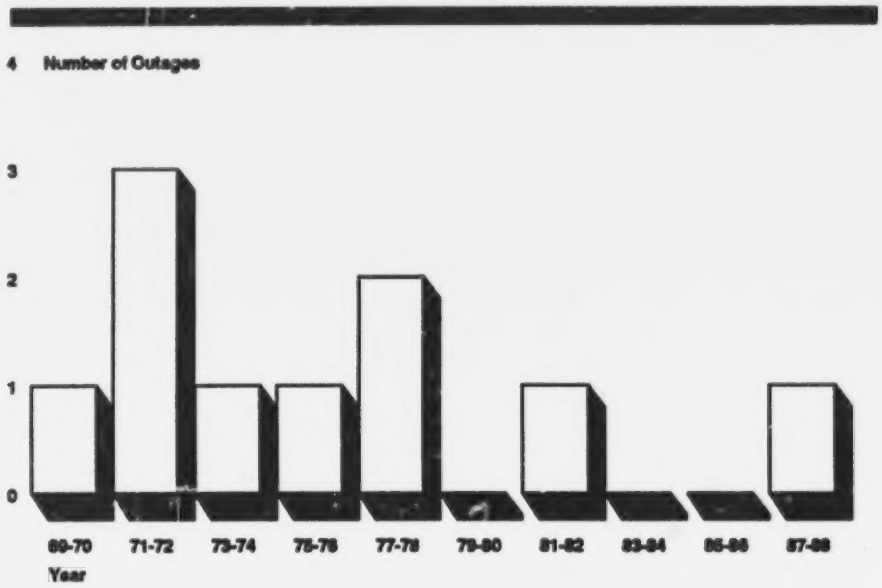
Long distances between electricity generation centers and load centers (customers) make Hydro-Quebec's transmission system vulnerable to system-wide outages. According to Hydro-Quebec officials, the transmission system was constructed with a limited number of parallel long-distance transmission lines because such lines are costly. Additional parallel lines would reduce the risk of system-wide outages. Further, because hydroelectric power generation units can restart the power generation process in a relatively short time period, the inconvenience of power outages to Hydro-Quebec's customers is minimized.

Hydro-Quebec's transmission system faces a higher risk of system-wide outage than other neighboring systems because the other systems are based on thermal generating sources that are closer to load centers. While the Hydro-Quebec system may have provided the best balance between reliability and cost for Hydro-Quebec's domestic customers at the time it was built, Hydro-Quebec recognizes that the system may need to be improved to support its current domestic market and its growing export sales program.

The Number of Power Outages Is Decreasing

The frequency of the utility's system-wide outages has decreased in recent years. As shown in figure III.1, Hydro-Quebec experienced eight system-wide power outages during the 10-year period from 1969 through 1978, but the utility experienced only two such outages during the next 10-year period from 1979 through October 1988. The most recent Hydro-Quebec system-wide outage occurred on April 18, 1988. Hydro-Quebec officials cite a series of short circuits during winter weather conditions and the failure of load-shedding equipment as the immediate factors contributing to this outage.

Figure III.1: Frequency of Hydro-Quebec System-Wide Power Outages, 1969-88



Source: Chart developed by GAO based on data provided by Hydro-Quebec.

Number and Capacity of Power Interconnections Is Increasing

The number and capacity of Hydro-Quebec's power interconnections with U.S. utilities are scheduled to increase in the next 4 years, as shown in table III.1. Currently, the capacity of Hydro-Quebec's four interconnections that are tied to Hydro-Quebec's main grid totals 2,590 MW. This capacity will increase to 3,900 MW in 1990. A fifth interconnection was planned to be completed in 1992 in conjunction with Central Maine Power's recently disapproved power purchase contract with Hydro-Quebec. Should that interconnection be completed, the total interconnection capacity will increase to 5,000 MW, nearly double the current levels.

Table III.1: Total U.S./Hydro-Quebec Main Grid Interconnection Capacity

Capacity in megawatts

Interconnection	1988	1990	1992
New York	1,000	1,000	1,000
Vermont	200	200	200
Maine[a]	700	700	700
NEPOOL	690	2,000	2,000
Maine[b]	•	•	1,100
Total	**2,590**	**3,900**	**5,000**

[a]This transmission line is interconnected to New Brunswick which, in turn, is interconnected to Hydro-Quebec.

[b]This interconnection was to support the recently disapproved Central Maine Power purchase contract. As of January 24, 1989, DOE's review of a Presidential Permit application for this interconnection had been suspended at the request of Central Maine Power.

Actions to Minimize Risk of Hydro-Quebec System-Wide Outages

A number of steps are being taken to mitigate the effects on neighboring systems of a Hydro-Quebec system-wide power outage. Currently, NEPOOL and other interconnected power pools have agreed to operate existing interconnections so that the total amount of power being imported from Hydro-Quebec's main grid does not exceed about 2,200 MW at any one time. Our understanding, based on discussions with U.S. utility representatives, is that the 2,200-MW limitation, which is less than the interconnections' full capacity of 2,590 MW, represents the amount of power that the U.S. utilities could lose suddenly and still provide adequate power to serve their customers. Sudden power losses greater than 2,200 MW (under current system configurations) could cause the U.S. utilities to be vulnerable to system-wide outages.

As shown in table III.1, future interconnection capacity will exceed the current 2,200-MW operating limit. However, as shown in table III.2, the 2,000-MW NEPOOL interconnection is being designed so that it can be isolated from Hydro-Quebec's main grid. When this line is isolated, it is not subject to system-wide outages; consequently, power transmitted over this line would not be counted against the 2,200-MW operating limitation for importing power from Hydro-Quebec's main grid. Hydro-Quebec expects to operate the line in the isolated mode between April and November each year and at times during the December through March period. When the line is not isolated, imports over all interconnections will be limited to about 2,200 MW.

Table III.2: U.S./Hydro-Quebec Interconnection Capacity: Isolated Mode (I) and Not-Isolated Mode (NI)

Capacity in megawatts

	1988		1990	
Interconnection	**NI**	**I**	**NI**	**I**
New York	1,000	•	1,000	•
Vermont	200	•	200	•
Maine[a]	700	•	700	•
NEPOOL	690	•	•	2,000
Total	**2,590**	•	**1,900**	**2,000**

[a]This transmission line is interconnected to New Brunswick which, in turn, is interconnected to Hydro-Quebec.

In September 1988, DOE issued a Presidential Permit for NEPOOL's Phase II interconnection that places operating conditions on the interconnection consistent with the operating limitations discussed above. A permit application for the planned 1,100-MW Central Maine Power interconnection with Hydro-Quebec has been under review by DOE. However, following a recent Maine Public Utilities Commission disapproval of a Central Maine Power proposed purchase of Hydro-Quebec power, Central Maine Power requested, according to a DOE official, that DOE suspend its review of Central Maine's Power's Presidential Permit application.

To improve system reliability, during the last 10 years, Hydro-Quebec has increased the number of transmission lines to its hydroelectric generation facilities in Northwestern Quebec Province at James Bay and has incorporated a number of technological improvements in its transmission system. Hydro-Quebec has submitted plans for additional improvements to the Northeast Power Coordinating Council. Hydro-Quebec officials stated that if the Council responds favorably, the utility plans to spend up to $800 million (Canadian), beginning in 1989, for additional improvements to meet the reliability criteria of the Council and thus reduce the likelihood of system-wide outages. These officials believe that the improvements will result in the lifting of U.S. limitations on the amount of power exported from Hydro-Quebec.

Objectives, Scope, and Methodology

The objective of our review was to update information in our previous report on Canadian electricity imports (RCED 86-119, April 30, 1986) that pertained to (1) the status of firm-power imports from Canada and (2) the technical reliability of electricity imported from Quebec. We limited the scope of our review to New England and New York, where long-term firm-power contracts are being signed and where technical reliability concerns had existed.

For information on firm-power imports, we interviewed utility officials in New England and New York and reviewed firm-power contracts and related documents as well as regional load and capacity forecasts. We also discussed firm-power imports with state regulators in New England and reviewed testimony and other documents provided to the Maine Public Utilities Commission for its public hearings. We did not meet with New York Public Utilities Commission officials because the New York contracting party for Canadian power—the New York Power Authority—is a state agency and is not subject to public utility commission review.

We discussed concerns about the technical reliability of imports from Quebec with officials at regional and interregional power pools, including NEPOOL and the Northeast Power Coordinating Council. We reviewed NPCC's technical study submitted to DOE in support of NEPOOL's Presidential Permit application. To determine the status of DOE's activities in the import area, we discussed DOE's review of Presidential Permit applications and we reviewed DOE publications on Canadian electricity imports.

We discussed firm-power imports with Canadian government and utility officials. With Hydro-Quebec, we discussed technical reliability concerns, planned system improvements, and recent power interruptions. We discussed Hydro-Quebec's planned system improvements with a Quebec Ministry of Energy and Resources official. With the New Brunswick Electric Power Commission, we discussed its proposal to export additional firm power to the United States. We obtained data on electricity trade with the United States from the Canadian National Energy Board, a regulatory agency.

We did not obtain agency comments on this report. We performed our work in accordance with generally accepted government auditing standards. Our audit work was conducted between February 1988 and January 1989.

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